

The
FOREST INSECT
and
DISEASE
situation



LAKE STATES FOREST EXPERIMENT STATION
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FOREWORD

The forest insect and disease problems in the Lake States region are of increasing concern. Past losses in tree growth and tree mortality are indicative of how serious such problems have been and may continue to be in the years ahead. In order to adequately appraise the region-wide insect and disease situation, the Lake States Forest Experiment Station has undertaken an annual summary of information pertaining to the present status of insect infestations and disease infections.

To prepare such a report it is essential that use be made of all available information. Many individuals, state organizations, and forest industries have been helpful. The Station, through its insect survey and research staff, collected some of the original material presented in this report.

The active and willing cooperation of the many individuals and agencies is gratefully acknowledged. Special acknowledgment is made of the information and help given by the following:

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Cover picture: An adult female larch sawfly ovipositing in the new shoot of tamarack.

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SITUATION

LAKE STATES, 1956

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and
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By

L. C. Beckwith and R. L. Anderson^{1/}

INTRODUCTION

Insects and disease play an important part in the reduction of our vast forest resource. Each year they cause large losses in timber growth and result in tree mortality. But that is not all: These agents attack the forest from seed to finished product. Stocking levels are lowered, growth is retarded, and trees are deformed, thus reducing both quality and quantity of forest products. The protection of our forests against these destructive agents is the responsibility of everyone concerned with the national economy.

HIGHLIGHTS OF 1956

The most important aspects of the insect and disease situation in the Lake States region are presented briefly in the next few pages. For more detailed discussion see sections on Major Forest Insect (or Disease) Pests.

^{1/} Entomologist and Pathologist respectively of the Lake States Forest Experiment Station. The Station is maintained at St. Paul 1, Minn., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of Minnesota.

Insects

Plantation Insect Pests of Major Importance

In the Lake States the insect pests of plantations, which cover 2 million acres of land, are of major importance. The cost of establishing a coniferous plantation, especially when compounded through rotation age, easily justifies reasonable costs of protection against insect enemies. The major plantation insect pests in the Lake States during 1956 are mentioned below.

The Saratoga spittlebug continues as a major insect enemy of red pine plantations in Wisconsin and Upper Michigan. In 1956, 2,935 acres were aerially sprayed with a DDT-oil solution to control the insect on national-forest lands.

The European pine shoot moth is the number one insect enemy of red pine plantations in the Lower Peninsula of Michigan. It is also an important pest on Scotch pine. The insect is becoming more prevalent in southern Wisconsin.

The white-pine weevil continued to be a major factor in growth and quality reduction of white pine, jack pine, and Norway spruce throughout the Lake States. It is also becoming more important on red pine in this area.

The pine tortoise scale periodically builds up and kills large areas of jack pine plantations in this region. The infestations in Wisconsin and Michigan have declined.

Defoliators Are Major Pests in Natural Stands

Insect enemies of natural stands were also important in 1956 in the Lake States. The major pests in this category were all defoliators.

Spruce budworm populations have increased in northern Minnesota causing an increase in the extent and severity of heavy defoliation, especially along the Canadian border. Egg mass surveys indicate this trend will continue in 1957.

Jack-pine budworm infestations on 22,000 acres of jack pine on Mosinee Paper Company lands in Wisconsin were aerially sprayed by the Company to control this pest. Surveys in the Lake States indicate that populations in Wisconsin and Minnesota are heavy enough to warrant possible control measures on approximately 315,000 acres in 1957. The infestations in the Upper Peninsula of Michigan remain at a low ebb.

The larch sawfly continued in epidemic status throughout northern Minnesota. Tree mortality is occurring on some of the better tamarack sites in this area. Populations are also increasing in widely scattered stands in Wisconsin and Michigan.

The forest tent caterpillar infestation in Minnesota remained approximately the same as in 1955. Defoliation was prevalent throughout northern Wisconsin and extended into Gogebic County in the Upper Peninsula of Michigan.

Diseases

Most of the common tree diseases causing damage in this region are not subject to as pronounced buildups and declines as are many of the insects. On the other hand, new or recently introduced diseases may show marked changes in distribution and prevalence. Well-established diseases may have occasional years with considerable change in prevalence if they are markedly influenced by special conditions, such as unusual weather. Even for many diseases with "wave" infection years, such as the rusts, the damage resulting from the "wave" is spread over a number of years, thus reducing year-to-year fluctuations in impact of the disease.

For most of our diseases, the 1956 situation should not be considered as unique but rather as typical of the situation prevailing during the present decade. Since this is the first regionwide situation report on forest diseases, primary emphasis is given to the present or potential impact on forest productivity rather than to change from past years.

Diseases Present Serious Problem
in Nurseries and Plantations

Four diseases are of considerable importance in one or more of our Lake States nurseries.

Damping-off, which reduces productivity and increases costs, is a perennial problem in forest nurseries. The severity of the problem varies from nursery to nursery and from year to year. Severity during 1956 is estimated to have been about average.

Root rot of white pine has been causing severe losses at the Chittenden Nursery in recent years. Losses were relatively severe in 1956.

Jack pine-oak rust has occurred on a relatively high percent of jack pine stock in some nurseries.

Jack pine-sweetfern rust was noted on a rather high percent of jack pine in some plantations. The stock may have been infected when planted.

Plantations frequently present a disease problem due to the unnatural conditions under which the trees are growing.

Fomes annosus, a fungus that causes serious root rot, is known to be present but so far is not known to be causing noticeable damage in this region.

Red pine canker is a new disease found this summer in red pine plantations on the Ottawa National Forest.

Red pine twig diseases, showing a variety of symptoms, have been found in recent years associated with twig and branch mortality. Damage has been severe in local areas. Prevalence did not appear very high this year.

Armillaria mellea and poor root development are associated with an excessive amount of mortality which has been occurring in some small sapling-size trees in red pine plantations.

Nine Diseases are Presently
or Potentially Important in Natural Stands

Diseases which are causing losses in natural forest stands include the following:

Heart rots and butt rots are probably causing a greater reduction in growth and timber quality than all other diseases combined.

Hypoxyylon canker is killing a greater volume of timber in the region than all other diseases combined.

White pine blister rust is a major factor in discouraging regeneration of many good white pine sites to this species. It has a serious impact on the forest economy of the region.

Oak wilt is currently causing some mortality and has an unknown potential for future damage. It could conceivably eliminate oak as a commercial species unless effective control measures are developed.

Dwarf mistletoe damage will become more severe in the future unless control measures are employed. Natural control of this disease has been largely eliminated by current forest practices.

Other diseases present in natural stands are not currently causing a large loss in volume, but some may be potentially serious and others are causing reduction in quality.

Dutch elm disease is now in Michigan and Wisconsin. There is no obvious reason why it should not continue to spread, intensify, and cause damage here comparable to that in other regions.

A maple dieback disease has been noted in Wisconsin. Its actual potential is unknown.

Birch decadence, a dying-back of the tops in birch, has been rather prevalent in the Upper Peninsula of Michigan. The nature of the disease is unknown.

Discoloration in aspen wood is common and is considered a serious defect for many uses, such as high-quality paper. Much of this discoloration evidently is associated with the bacterial wetwood disease.

MAJOR FOREST INSECT PESTS IN 1956

The status of the major forest insects in the Lake States is outlined in the following pages. Only those of primary importance are discussed in detail. Brief mention is made of some of the less important species.

Spruce Budworm-- Defoliation Increasing

The spruce budworm (Choristoneura fumiferana (Clem.)) is potentially one of the most dangerous pests of the spruce-fir forests in North America. Approximately 20 million cords of balsam fir were destroyed by this insect in the Lake States during the last major outbreak (1912-1923). An infestation, first noticed in 1954, again threatens the spruce-fir forests of the Lake States.

In 1956, an aerial survey of the spruce-fir type in northern Minnesota showed that heavy defoliation extended farther south than in 1955 (fig. 1). This survey indicated that 77 percent of the balsam fir within the spruce-fir type suffered defoliation noticeable from the air; 30 percent was heavily defoliated. The area of heavy damage was along the Canadian border east of International Falls with a southward extension to Lake Vermilion in the central part of St. Louis County. Heavy feeding also occurred just north of Nett Lake in Koochiching County, in the Northwest Angle in the Lake of the Woods, and on a Wind Lake island in Lake County near the Canadian border. The trees suffered almost complete defoliation on the Wind Lake island. Medium to light defoliation extended south from the heavily defoliated areas.

Egg mass surveys were conducted at 68 collecting points throughout northern Minnesota. Twelve 15-inch branch samples were collected at each point. Analysis of the data showed an increase in the number of egg masses in practically all areas. The number per plot ranged from 0 to 251, and the number of eggs per mass averaged 19, the same as in 1955. Because of this increase in egg population the area of heavy defoliation in 1957 will probably increase in extent and severity.

Although the budworm is present in Wisconsin and Michigan, defoliation was not noticeable. No new areas of spruce budworm outbreaks were found in Michigan. Collecting plots distributed throughout the Upper Peninsula indicated that the budworm population was at a very low level or absent in most areas. The population in Keweenaw County apparently is declining.

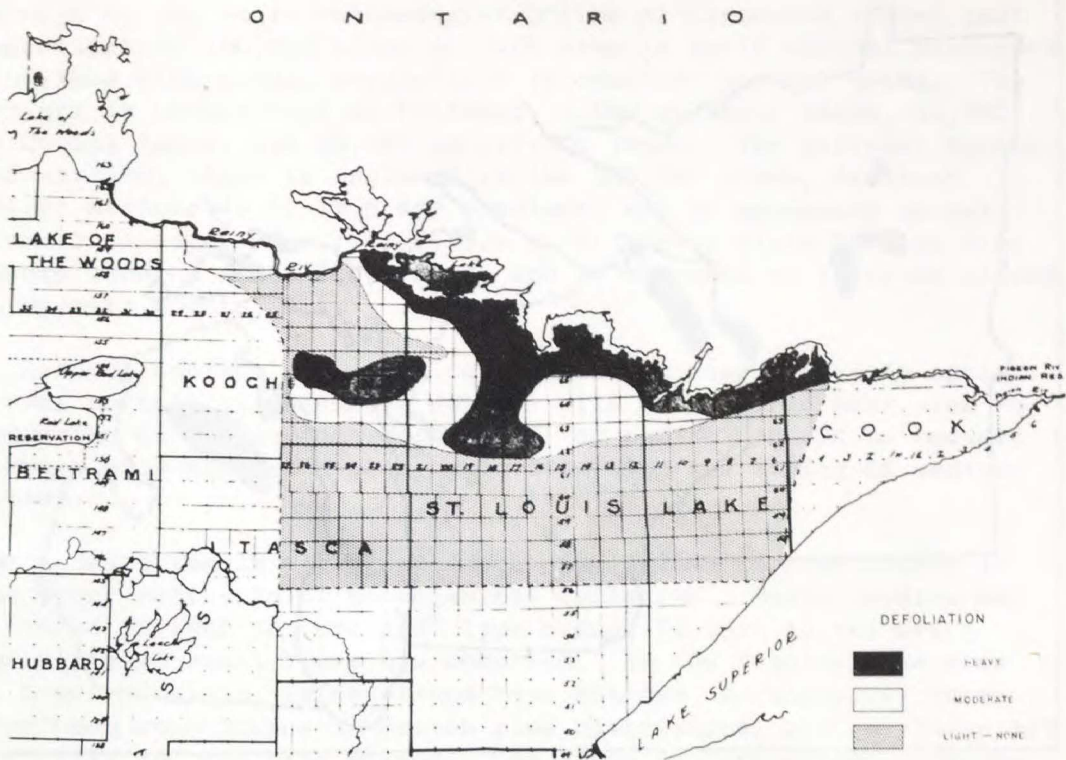


Figure 1.--Areas of noticeable defoliation by the spruce budworm in northern Minnesota, 1956, based on aerial survey as outlined by dotted line.

The budworm is not expected to become a serious threat over most of the Upper Peninsula because of the scattered occurrence of the balsam stands and their variability in size, age, stocking, and species mixtures.

Jack-Pine Budworm--
Control Necessary

The jack-pine budworm (*Choristoneura pinus* Free.) populations increased in Minnesota and Wisconsin but remained relatively low in Michigan. The areas of known infestation are shown in figure 2. The Mosinee Paper Company in cooperation with the Wisconsin Conservation Department and the University of Wisconsin aerially sprayed 22,000 acres of jack pine on Mosinee lands in Wisconsin. In addition, experimental aerial spraying



Figure 2.--Areas of jack-pine budworm infestations,
Lake States, 1956.

was done by the Office of the State Entomologist of Minnesota and the Minnesota Conservation Department on 160 acres and 40 acres in the Bemidji and Brainerd areas respectively.

Extensive larval, pupal, and egg surveys were conducted by the Wisconsin Conservation Department on State and private lands in 1956. Based on these surveys, approximately 203,000 acres of jack pine in Wisconsin have been slated for possible control action next year. An additional 150,000 acres were lightly infested. Most of the infested areas are in the northwestern counties. An infestation covering about 10,000 acres in Marinette County in northeastern Wisconsin declined in severity.

Aerial and ground surveys by Lake States Forest Experiment Station personnel on the Washburn Ranger District of the Chequamegon National Forest indicated that 11,500 acres of jack pine were heavily enough infested to warrant possible control in 1957.

Surveys by the State Entomologist Office of Minnesota showed that approximately 100,000 acres of jack pine in north central Minnesota contained high enough populations to consider control needs. The acreage is broken down as follows: 7,000 on State lands, 13,000 on County lands, and 80,000 on private lands. The Beltrami County infestation, which is included in the 100,000 acres, declined rather noticeably in 1956 and treatment may be necessary on only a small acreage. The infestation in St. Croix State Park in Pine County covered about 3,500 acres and is adjacent to infested stands in Burnett County, Wis.

As natural factors may cause considerable winter and early spring larval mortality, intensive surveys will be required next year to determine if the acreage designated for control should be reduced. Surveys will also be necessary to determine the timing of control action.

The infestation in high-grade jack pine stands in Luce County in the Upper Peninsula of Michigan has collapsed. Heavy feeding was centered in 1956 in "orchard" type stands farther to the east; mortality of small trees has occurred. In the Higgins Lake area of Lower Michigan, infestations have shifted considerably; there have been some losses in Scotch pine plantations, but no widespread mortality in jack pine stands. The State is considering spraying 1,000 acres of red pine-jack pine plantations to save the red pine, which has been seriously defoliated. The overall infestation was about the same as in 1955, and considerably lower than in 1950 to 1953.

European Pine Shoot Moth-- Red Pine Scourge in Michigan
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The European pine shoot moth (Rhyacionia buoliana (Schiff.)) remained as one of the most serious plantation pests of red pine and Scotch pine in Michigan and Wisconsin. It is primarily a threat to young plantations; older plantations are not severely damaged. It is a very serious problem to Christmas tree growers in the infested area. Trees attacked by the shoot moth have little value in the Christmas tree market. Shearing used by many growers to make a conical form also aids in preventing heavy damage. Chemical control measures on forest plantations have not proven economically feasible.

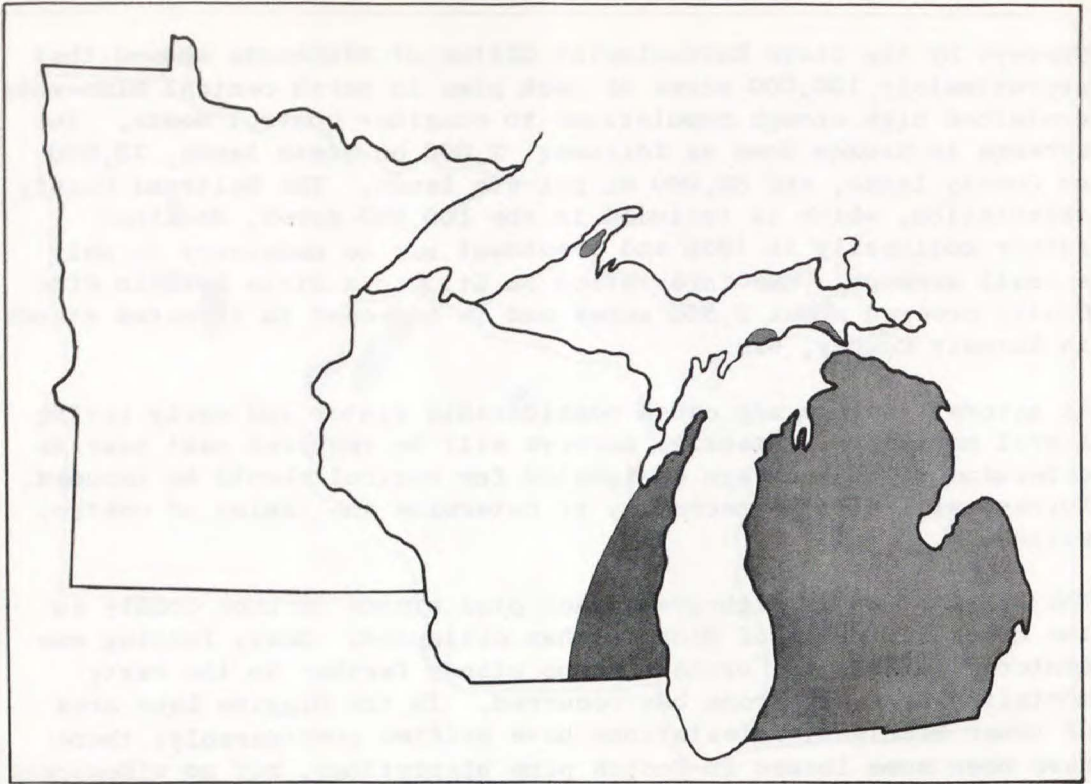


Figure 3.--General areas of European pine shoot moth infestations, Lake States, 1956.

The area of infestation (fig. 3) has increased over that in 1955. Serious injury occurred in the southern half of the Lower Peninsula and north along the west side to Grand Traverse County and on the east coast to Alpena County. Less serious infestations are found in most other areas of the Lower Peninsula; some have caused no damage, others have noticeably distorted the trees. In the Upper Peninsula the shoot moth has been present in Houghton County for some years, and was discovered in 1956 along U. S. Highway 2 in Schoolcraft and Mackinac Counties from Manistique to St. Ignace.

In Wisconsin the insect has spread west to Green County and north to Door County, covering a larger area than in 1955.

Saratoga Spittlebug--
Control Continues

The Saratoga spittlebug (Aphrophora saratogensis (Fitch)) remained as one of the major pests in red pine and mixed red and jack pine plantations in the Lake States. The adults withdraw copious amounts of sap from the young twigs, resulting in a reduction of tree vigor, stunting, deformity, and, in severe infestations, ultimate death of the tree or parts thereof. Many plantations are now tall enough (about 15 feet) so that they are tolerant to spittlebug damage. On the other hand, many new plantations are just reaching a height (about 3 feet) where the spittlebug can become a problem. These latter plantations sometimes must be sprayed three times to bring them through the susceptible height range.



Figure 4.--Nymphal sampling technique for Saratoga spittlebug, using a 1/10-milacre frame.

Nymphal surveys (fig. 4) were conducted on 8,056 acres of national-forest lands in Wisconsin and the Upper Peninsula of Michigan by National Forest Administration personnel in 1956. Spittlebug populations were considered heavy enough to warrant control on 2,723 acres in Wisconsin and 212 acres in Michigan. Aerial control was carried out using a DDT-oil solution; control was satisfactory.

Based on the above nymphal survey, 3,146 of the 8,056 acres were set up to be resurveyed during 1957. Adult sweep surveys carried out by the Lake States Station in the fall of 1955 and 1956 indicated that nymphal surveys must also be conducted in 1957 on an additional 9,099 acres in other areas of these national forests. The total survey acreage would be 12,245 (4,087 acres in Michigan and 8,158 acres in Wisconsin). It is expected that the actual acreage to be sprayed next season will be less than the 12,245 acres due to population decline.

The Wisconsin Conservation Department aerielly sprayed 351 acres of red pine plantations on State lands in Vilas County in 1956.

Population levels of the spittlebug remained generally low on State and private lands in Michigan as indicated by the absence of reports of moderate or heavy injury. They were also low in plantations on national-forest lands. At present the spittlebug is of little significance in Minnesota.

Larch Sawfly-- Tree Mortality Increasing

The larch sawfly (*Pristiphora erichsonii* (Htg.)) continued in epidemic status throughout northern Minnesota. Populations increased in tamarack stands throughout northern Wisconsin and Upper Michigan. In Wisconsin, the sawfly was found as far south as Monroe County; heaviest defoliation occurred in the northwestern part of the State. In Michigan sawfly populations are reported to have increased throughout the Upper Peninsula and the northern half of the Lower Peninsula. The heaviest defoliation is in the western half of the Upper Peninsula. An aerial survey, conducted by the Office of the State Entomologist of Minnesota and covering most of the tamarack type within the State, showed the total area of defoliation was much the same as in 1955. Moderate to heavy defoliation occurred in Koochiching, Beltrami, Itasca, Hubbard, Cass, and Aitkin Counties. Light defoliation was prevalent in most of the tamarack stands in the remainder of northern Minnesota.

Tamarack mortality due to the larch sawfly was apparent in the better tamarack sites in north central Minnesota. Mortality in 1954, when it was first observed, and in 1955 was restricted to the poorer sites in northeastern Minnesota. A ground survey of the study plots in the better sites showed that mortality was as high as 22 percent of the total number of trees; much of it occurred in the 2-inch diameter class. Some of this mortality undoubtedly was due to tree competition, but many of the trees killed were in a

codominant position and had ample space. The associated tree species, black spruce and white-cedar, did not die, ruling out the possibility of other causes such as high water. Tree mortality was not reported from Wisconsin or Michigan.

White-Pine Weevil--
Present Everywhere

The white-pine weevil (Pissodes strobi (Peck)) was prevalent in white pine and jack pine stands throughout the Lake States. Although not a tree killer, it commonly is the most important insect pest in plantations of these two pine species. Attacks by the weevil result in height loss, thus prolonging rotation age and causing deformity and a reduction in lumber quality. Weeviling was also reported on Norway spruce, Scotch pine, Austrian pine, and red pine. Attacks on red pine are becoming more common.

In Michigan, the heaviest damage was reported in the north half of the Lower Peninsula; less damage occurred in the south half and in the Upper Peninsula. Jack pine appeared to be the preferred host and seemed to be injured as severely as white pine.

Many of the Christmas tree growers in the Lower Peninsula annually spray their plantations, especially Scotch pine, with DDT to prevent attack by the weevil.

Gypsy Moth--
Spraying Program Continued

The following report covering the gypsy moth (Porthetria dispar (L.)) trapping and control program in the vicinity of Lansing, Mich., was prepared by the Bureau of Plant Industry, Michigan State Department of Agriculture.

"As a result of the trapping program during the summer of 1955, there were twenty-three traps that attracted a total of 32 moths. From these finds, an area of approximately 98,860 acres was established and sprayed with the use of five Stearman 450 horse-power airplanes. The spraying operations began on May the 7th and were completed on May 22nd. A heavy amount of rain fell during the first two weeks causing a change in the use of air fields. Three of the fields could not be used because of the water soaked turf and this caused longer ferrying distances for the contractor.

"In the latter part of June, a trapping program was initiated to check on the effectiveness of the spraying operation and to detect any new infestations which might be present. A total of 4,942 traps were used to survey approximately 1,445,760 acres of territory. Two moths were recovered this year. One find was located 2 miles northwest of the largest area sprayed this spring. The other moth was trapped nine miles southeast of an area where thirteen egg clusters were found and twelve square miles had been sprayed.

"Once again an area to be sprayed will be determined from these finds and the operation will take place in the spring of 1957. In order to safely say that this pest has been eradicated, it will be necessary to have two years of negative trapping results."

Forest Tent Caterpillar-- Status Quo

The forest tent caterpillar (Malacosoma disstria Hbn.) infestation in Minnesota in 1956 remained about the same as in 1955. Heavy defoliation was confined to small scattered areas in the north-eastern part of the State, largely in the southeastern end of St. Louis County. The current outbreak appears to have diminished.

A series of light traps was established throughout northern Minnesota in 1956 by the Department of Entomology and Economic Zoology of the University of Minnesota. The number of adults caught in these traps ranged from 0 to 3,525. The intention is to maintain these traps to detect the next major outbreak at the earliest possible moment.

In Wisconsin, widely scattered defoliation occurred throughout the northern part of the State. Defoliation was moderate to severe in Douglas, Bayfield, Ashland, and Iron Counties. The Iron County infestation extended into Gogebic County in the Upper Peninsula of Michigan.

Pine Tortoise Scale-- Periodic Tree Killer

In 1956, pine tortoise scale (Toumeyella numismaticum (P. & McD.)) populations were reported as very light in Wisconsin. The insect was found scattered throughout jack pine areas in Minnesota. Severe infestations were noted in plantations near Brainerd and

Bemidji. An outbreak was discovered late in 1955 in Chippewa County, Mich., after it had killed the majority of jack pine on 400 acres. The infestation succumbed during the summer of 1956, probably due largely to predators. A similar situation existed in the Stonington Peninsula in Delta County.

The pine tortoise scale periodically becomes an important pest of jack pine in the Lake States. It generally follows a definite pattern: population buildup, tree death, and then a rapid decline in population due to predators and parasites. In most stands, approximately 7 percent of the trees escape injury, probably because of genetic immunity; the scales apparently cannot survive and increase in numbers on these trees.

Pine Sawflies-- Infestations Widely Scattered
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Infestations by several species of Neodiprion and Diprion were widely scattered throughout the Lake States; heavy feeding occurred in a few areas.

The European pine sawfly (Neodiprion sertifer (Geoff.)) continued to be the major defoliator of red and Scotch pines in the southern half of Lower Michigan; it was generally distributed throughout that area with no apparent fluctuations. It was most serious in Christmas tree plantations, where defoliation greatly reduces the value of the trees. This species was also present in southern Wisconsin.

Widely scattered outbreaks of the red-headed pine sawfly (Neodiprion lecontei (Fitch)) were reported in the northern half of Lower Michigan and also in the Upper Peninsula. Heavy feeding was reported from Sherburne County, Minn.; some control work was done in plantations in this location. Light infestations occurred on red and jack pines over most of Wisconsin.

Other species which build up in localized areas were the introduced pine sawfly (Diprion similis (Htg.)) on white pine (heavy infestations of some stands near Brainerd, Minn.), the jack-pine sawfly (Neodiprion pratti banksianae Roh.) on jack pine, and the red-pine sawfly (Neodiprion nanulus Schedl) on red pine. The Swaine jack-pine sawfly (Neodiprion swainei Midd.) was reported for the first time in Minnesota near Littlefork on jack pine.

Walkingstick--
Even-Year Brood

The even-year brood of the walkingstick (Diapheromera femorata (Say)) defoliated oak on 800 acres in Dickinson County (Upper Peninsula) and 45,000 acres in Ogemaw County (Lower Peninsula). In the latter area some trees have died after 25 years of alternate-year defoliation.

Boxelder Insects
in Shelterbelts

One of the foremost shelterbelt problems in North Dakota in 1956 was the "blight" symptoms on boxelder. The condition is widespread in North Dakota and also occurs in Montana, Minnesota, and the Prairie Provinces of Canada. The typical symptoms are small chlorotic leaves on the new shoots; not all the leaves on the shoots are affected. The "blight" appears to be of major importance in nurseries, but it is also found in field plantings.

In all cases examined, a small lepidopterous larva, tentatively identified as the boxelder twig borer (Proteoteras willingana (Kearf.)) was found boring either in the terminal bud axis or a lateral leaf axis. Three possibilities are suggested: (1) The condition is a physiological response of the plant brought on by the insects boring, (2) a virus, bacteria, or fungus was introduced by the insect, (3) the insect is incidental to the disease. If a virus is causing the condition, possibly it is being transmitted by other insects such as aphids, plant bugs, leaf hoppers, or thrips.

Miscellaneous Hardwood
Defoliators

From time to time defoliation of hardwood by numerous insect species becomes conspicuous. In 1956, the large aspen tortrix (Archips conflictana (Wlk.)) was responsible for defoliation of aspen throughout the Upper Peninsula of Michigan; in some areas approaching two townships in size, 75 percent or more of the leaves were eaten. Defoliation was also reported in Oneida County, Wis. The fruit tree leaf roller (A. argyrospila (Wlk.)), primarily an orchard pest which periodically invades forest stands, defoliated the oak on

214,500 acres in Crawford County, Mich. This is the first reported defoliation in Lower Michigan. Although tree mortality is not expected, the insect is considered a serious nuisance by local residents because the larvae crawl over the buildings. A leaf roller, suspected to be closely related to argyrospila, fed noticeably on sugar maple at the Dukes Experimental Forest in Upper Michigan and at the Menominee Indian Reservation in Wisconsin. The red-humped oakworm (Symnerista albicosta (Hbn.)) stripped oak on 8,000 acres in Lower Michigan. Populations of the variable oak leaf caterpillar (Heterocampa manteo (Dblly.)), which completely defoliated large areas of oak and birch in northwestern Minnesota in 1955, declined very materially this year. The closely related saddled prominent caterpillar (H. guttivitta (Wlk.)) caused severe defoliation of beech and sugar maple in the Door County Peninsula; however, a disease killed many of the larvae in the areas of heaviest infestation.

MAJOR FOREST DISEASES IN 1956

The following pages discuss briefly some of the major forest disease pests in the Lake States. Information on severity is meager, and much additional survey work would be required to treat this subject adequately.

White Pine Root Rot Still Severe

A root rot has been causing serious loss of white pine seedlings and transplants for many years in the Chittenden Nursery at Wellston, Mich. This disease is specific to white pine and spruce. Losses frequently run as high as 20 to 30 percent in a single year and have been as high as 95 percent. The disease has not been reported in other nurseries in the region where white pine or spruce are produced. The prevalence of the disease varies from year to year and was relatively severe in 1956. The progressive deterioration of the root systems on the affected trees is associated with chlorosis and stunting of the tops, followed by death. The disease can be controlled by application of $1\frac{1}{2}$ ounces of formaldehyde per square foot or 1.6 to 2 pounds of methyl bromide per 100 square feet of soil prior to seeding or transplanting. The cause of the disease has not been determined.

Jack Pine-Oak Rust Infects Nursery Stock

The jack pine-oak rust (Cronartium cerebrum) occasionally causes severe infection in jack pine nursery stock. Some nurseries have had to cull as much as 20 to 40 percent of the lifted stock because of the presence of the rust galls. Such severe losses occur only occasionally, following a year when weather conditions apparently were unusually favorable for infection. Culling is necessary, as seedlings with stem infection almost invariably die within a few years.

Jack Pine-Sweetfern Rust
May Cause Severe Nursery Infection

The jack pine-sweetfern rust (Cronartium comptonia) was found in sapling-size plantations. Two plantations were checked in which 20 to 30 percent of the trees were infected, and information was received of a plantation with 80 percent infection. This rust can kill small trees, but if an infected tree survives until it is 3 inches d.b.h. it usually will not die. The nature of the infections found in the plantations strongly indicates that the infection occurred in the nursery. Therefore, nursery infection may be severe on occasion. This rust does not produce obvious symptoms on seedlings, as does the pine-oak rust; hence, infection probably would not be noted.

New Disease Found
on Red Pine

Examination of red pine plantations on the Ottawa National Forest in Michigan, where damage had been reported, showed that a canker disease was associated with the injury. The cause has not been determined. The cankers seem to originate at any point on the stem or branches. There was deep snow last year in the area where the disease was found, but it is not known if this is associated with development of the disease.

Injury From Red Pine
Twig Disease Continues

Serious twig and branch mortality has been noted in small areas on red pine plantations for several years, especially on the Nicolet National Forest in Wisconsin and the Ottawa National Forest in Michigan. In some instances the flagging is obviously a result of spittlebug injury and burn blight. In many instances, however, other factors apparently are involved, since the symptoms differ and have been noted in Minnesota far removed from possible spittlebug injury. The variety of symptoms found suggests that a number of factors are responsible. The more severe types of injury are found in depressions and the more open areas and appear to be associated with site conditions. In 1956 damage was apparently about average.

Excessive Red Pine Mortality Occurring

During recent years many reports have been received of mortality in red pine plantations, especially in Wisconsin and the Upper Peninsula of Michigan. Much of this mortality, primarily in sapling-size stands, is not associated with the diseases discussed in the preceding paragraphs. The aboveground parts of the trees show no symptoms other than the rather rapid decline and death. Excavation of the root systems reveals that all of these trees are heavily infected with Armillaria root rot. Whether the Armillaria is the primary factor is questionable, since much experimental work has provided evidence that Armillaria is usually secondary. The affected trees generally have very poorly developed root systems, some of which is undoubtedly a result of improper placement of the roots at the time of planting.

Decay is Our Greatest Destroyer of Timber Volume

It has been estimated that stem and butt rots are responsible for about 70 percent of the reduction in forest productivity attributable to diseases. Decay affects all species in the Lake States but causes the greatest losses on the 9,308,000 acres of northern hardwood type, the 18,451,000 acres of aspen type, the 11,052,000 acres of other hardwoods, and the 4,111,000 acres of spruce-balsam fir. The continuing progress in improved forest management and utilization will materially reduce the future impact of these diseases. The great volume of rotten cull trees left standing in the woods accounts for about 80 percent of the decay loss. Not only is the entire volume of such trees lost, but also they occupy space that could be used by other trees for the production of sound wood. Rotten cull trees have accumulated because: (1) Some hardwood species are not utilized extensively and thus remain standing beyond their pathological rotation, (2) some areas have poor accessibility to markets and timber is not cut as soon as it should be, and (3) many cull trees are left standing on logged areas. Planting and natural conversion will eventually replace aspen on much of the present type area with species less susceptible to decay.

Hypoxylon Canker Causes
the Most Mortality

Data from about 500 sample plots, much of which has been contributed by industrial foresters, indicates that Hypoxylon canker, caused by Hypoxylon pruinaum, kills about 1 to 2 percent of the standing aspen volume each year. This means the annual loss may be as high as 1.4 million cords. It is second only to decay in disease impact on forest productivity and accounts for about 20 percent of the estimated total loss from diseases for the region. Considerable evidence indicates that the amount of infection occurring varies from year to year. In Minnesota, where we have the best data of this kind, the prevalence of infection declined decidedly after 1950, and then increased appreciably in 1954 and again in 1955, when it reached the approximate level of 1950 (fig. 5). No positive control measures are known, but trees are more susceptible to infection and are killed more quickly in poorly stocked and patchy stands.

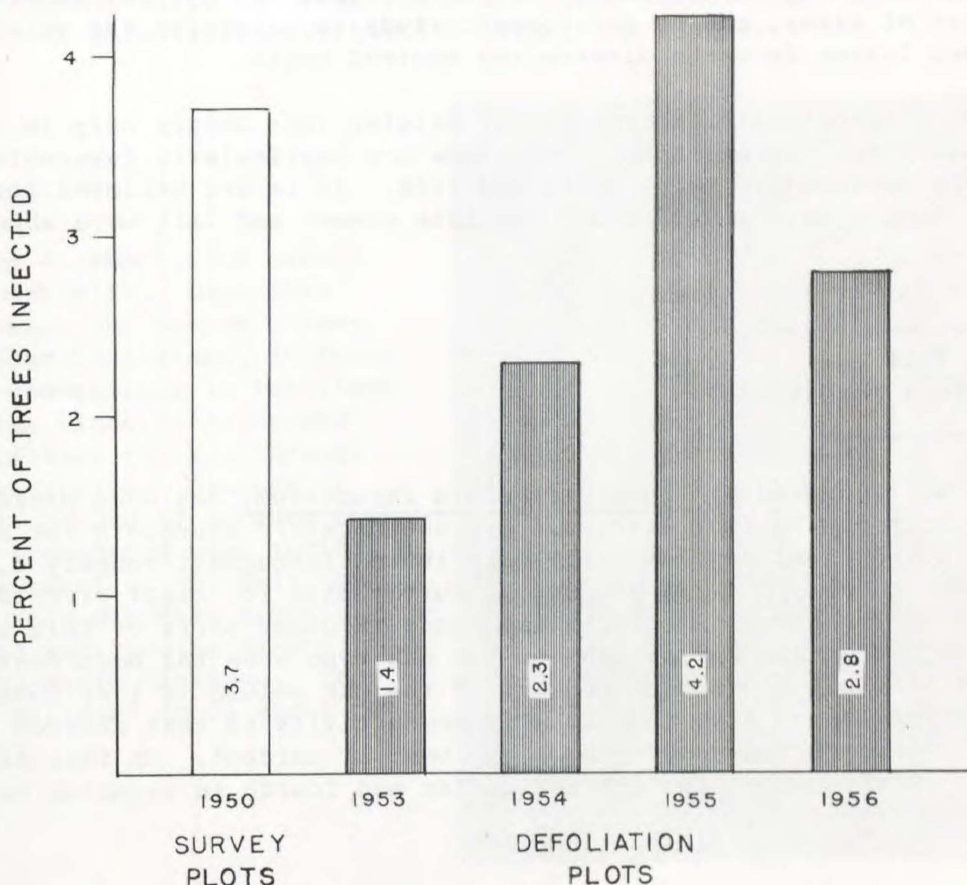


Figure 5.--Population trends of Hypoxylon canker.

White Pine Blister Rust
Losses Continue

The impact of white pine blister rust (Cronartium ribicola) in terms of current damage and expenditures for control is large; it is estimated to rank third for diseases. Its greatest importance, however, lies in the cumulative effect it has had on the natural and artificial regeneration of many potentially good white pine sites. Many such sites are now supporting less valuable species because of rust mortality in natural regeneration, and white pine has not been used in many planting programs because of the rust hazard. The influence of the disease on the forest economy of the region is considerably greater, therefore, than its current impact on the present relatively small acreage (414,000 acres) of white pine type. Control by ribes eradication continues to be the major method for reducing losses. During 1956 ribes were removed from 86,076 acres of control area in the Lake States. Efforts are being made to improve control practices by breeding white pine resistant to the disease, by determining the influence of the microclimate on rust hazard for given types of sites, and by an economic study to determine the relation between losses from the disease and control costs.

Severe infection of white pine by blister rust occurs only in occasional "wave years" when weather conditions are particularly favorable. Wave years occurred in 1950, 1951, and 1954. It is not believed that 1956 was such a wave year because the late summer and fall were abnormally dry.

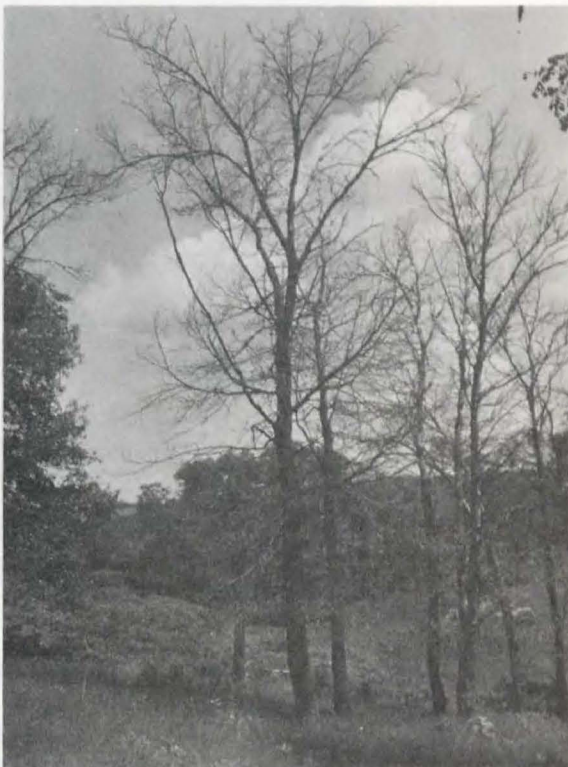
Oak Wilt Has
Serious Potential

Oak wilt, caused by Endoconidiophora fagacearum, has been present in the southern half of Wisconsin and southeastern Minnesota for many years. It is prevalent and generally distributed throughout roughly 4,000,000 acres of oak type. By projecting survey data for eight Wisconsin counties on the basis of observations made in other parts of this area, it appears that about 2 percent of the oak type area has been destroyed to date and that about 0.25 percent of the oak volume is lost annually. This represents a serious loss in productivity in that absence of oak wilt would increase net growth by about 11 percent. On this basis, oak wilt is the number two disease killer and fourth in reducing current productivity.

Much of the available evidence suggests that, if not controlled, the disease will continue to spread slowly and intensify until the oak type is essentially eliminated. No positive conclusions can be reached, however, because of the unknown history of the disease. Maybe it has always been here, flared up due to some unusual set of circumstances, and will subside again. Also, we do not know enough about its epidemiology to predict future prospects with any accuracy. The most that can be said is that to all appearances it is a very serious threat to the future of oak in this region.

There has been no evidence of any appreciable northward spread of the disease in Minnesota and Wisconsin. It has, however, become established during recent years in Lower Michigan. During an aerial survey and ground check made on old locations of infection in Michigan in the summer of 1956, oak wilt was found in 110 locations in 17 counties. Seventy-three of the locations were new. Michigan is attempting to control the disease and is now using chemical treatments or cutting to kill infected trees and any oaks near enough to transmit the disease by root graft (fig. 6). During 1956 this control program involved treatment of the 249 diseased trees found and 1,034 surrounding oaks. Most of the trees were treated with 2,4-D amine; the rest were cut.

Figure 6.--Mortality caused by oak wilt. Once this disease has become established in a stand, it tends to concentrate in localized areas since it is spread from tree to tree through root grafts. Because of this method of spread, control measures must include treatment of not only obviously diseased trees but also surrounding oaks within root-graft distance. This is believed to be about 50 feet.



Dwarf Mistletoe
Will Spread and Intensify

Dwarf mistletoe (Arceuthobium pusillum) is undoubtedly the most serious enemy of black spruce. A rough estimate indicates that it is the fifth most important disease in reducing current forest productivity. The current impact of this disease on the black spruce type is comparable to that of oak wilt on oak type. At present, only a small portion of the type area is infected--3 to 11 percent--but on such areas damage is severe (fig. 7). This disease spreads very slowly but persists indefinitely once established. The present limited distribution is a result of a natural control factor, fire, which has been essentially eliminated. Fire destroys mistletoe but permits spruce regeneration. The reinvasion of burned areas is very slow, requiring many decades and even centuries, but it is also very sure. Unless control measures are employed as a substitute for fire, the evidence indicates that the disease will spread and intensify slowly until the entire type is affected and productivity materially reduced.

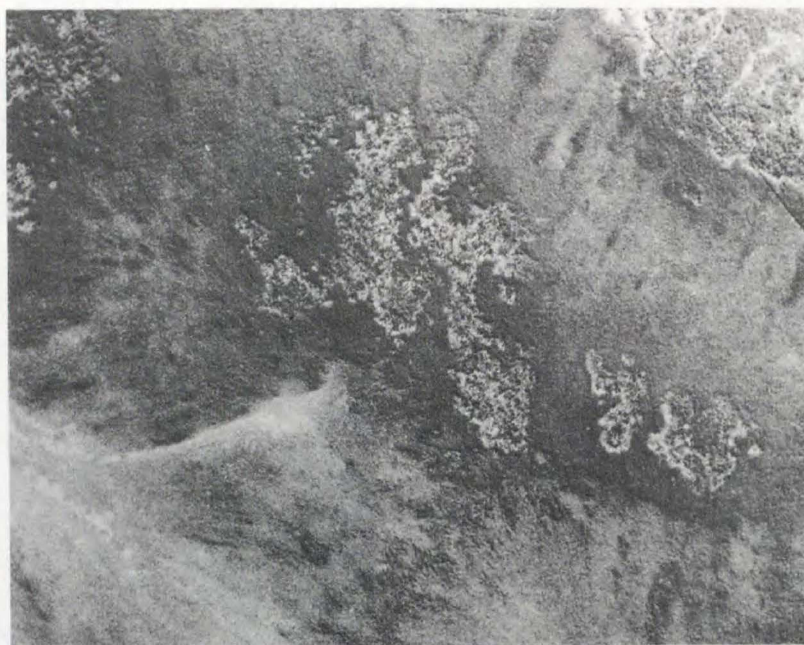


Figure 7.--Aerial photo of an even-aged stand of black spruce, showing a number of large patches infected with dwarf mistletoe. Note the serious reduction in stocking in these patches. The attacked trees grow very slowly and are seriously deformed.

Dutch Elm Disease
Invading Region

Dutch elm disease, caused by Ceratostomella ulmi and well known for the damage it has inflicted further south and east, now has a foothold in the region. In Michigan the disease was first found in Detroit during the summer of 1950. The Plant Industry Division, Michigan Department of Agriculture, reports that the survey and sanitation programs were intensified in 1956. Almost every community in most counties in the southern half of the Lower Peninsula were surveyed, and many new communities were found to be infected. Intensification of the survey accounted in part for an apparent increase in diseased trees from 5,774 in 1955 to 8,000 in 1956. Part of the increase, however, can be attributed to the normal rate of buildup in areas where the incidence of the disease was high, such as Grand Rapids and vicinity where 63 diseased trees were condemned in 1955 and 1,384 in 1956. As a result, the number of dead and dying trees ordered to be removed and destroyed in the State increased from 8,282 in 1955 to 16,000 in 1956.

This year the disease was found for the first time in southern Wisconsin, as was anticipated from its previous presence in northern Illinois. The Wisconsin State Entomologist reports that 63 infected trees were found in 14 municipalities of 6 counties. The 6 counties are: Milwaukee, Waukesha, Racine, Kenasha, Walworth, and Rock. All infected trees were removed and burned. The principal vector, the smaller European elm bark beetle, has been found in 22 counties, the furthest north being Shawano and Kewaunee.

So far, the disease has not been found in Minnesota. There is no reason, however, to believe that it will not continue to spread and intensify. Although elm is not considered among the more important commercial species, the disease will certainly have an impact on the tree economy in some sections of the region.

Maple Dieback
Found in Wisconsin

A dieback of maple has been observed in Wisconsin in recent years. The cause has not been determined; thus its potential for causing extensive damage in forest stands is unknown. A number of wilt diseases can cause dieback symptoms on maple, but they seldom become serious in

natural stands. Considerable verticillium wilt was found on both maple and elm in Wisconsin this summer, but it is not believed that this disease is responsible for most of the dieback noted.

Birch Decadence Noted in Upper Peninsula

In the Upper Peninsula of Michigan top dieback in birch has been quite prevalent. The cause is not known. It does not appear to be the more or less normal postlogging decadence since trees in undisturbed areas show symptoms. On the other hand, there is no evidence that we are faced with a problem of such serious proportions as the New England birch dieback of some years ago. Some twig and branch mortality is normal for birch, and only time will tell whether the excessive dieback was only a transient condition.

Discoloration in Aspen Hinders Utilization

Discolorations are very common in aspen wood. Since this condition requires bleaching, the increased costs of manufacture hinder utilization of aspen for high-quality papers. There appear to be several kinds of discoloration in aspen wood, but much of it may be associated with the bacterial wetwood disease. This disease does not cause mortality; its only known effect is to reduce quality of wood. Its widespread and common occurrence, however, indicates that it is a factor in production of high-quality aspen wood.

SOME RECENT STATION PUBLICATIONS

- Forest Tent Caterpillar, by Harold O. Batzer and William E. Waters. U. S. Forest Serv. Forest Pest Leaflet 9, 4 pp., illus. 1956.
- Hypoxylon Canker of Aspen, by R. L. Anderson. U. S. Forest Serv. Forest Pest Leaflet 6, 3 pp., illus. 1956.
- The Jack-Pine Budworm, by Harvey J. MacAloney and Arnold T. Drooz. U. S. Forest Serv. Forest Pest Leaflet 7, 4 pp., illus. 1956.
- The Larch Sawfly, by Arnold T. Drooz. U. S. Forest Serv. Forest Pest Leaflet 8, 4 pp., illus. 1956.
- A Method for Measuring the Insect Population on Trees 6 to 12 Feet Tall, by H. G. Ewan. Lake States Tech. Note 455, 1 p., illus. 1956. (Processed.)
- Nursery Root Disease Control by Soil Fumigation, by R. L. Anderson, D. D. Skilling, and E. D. Clifford. Lake States Tech. Note 449, 1 p. 1956. (Processed.)
- Predicting Emergence of the White-Pine Weevil from Hibernation, by Paul A. Godwin and James L. Bean. Forest Sci. 2: 187-189, illus. 1956.
- Oak Wilt Damage--A Survey in Central Wisconsin, by R. L. Anderson and D. D. Skilling. Lake States Sta. Paper 33, 11 pp., illus. 1955. (Processed.)
- Red Pine Scale, by James L. Bean. U. S. Forest Serv. Forest Pest Leaflet 10, 4 pp., illus. 1956.
- A Spruce Budworm Risk-Rating for the Spruce-Fir Types in the Lake States, by J. L. Bean and H. O. Batzer. Lake States Tech. Note 453, 2 pp. 1956. (Processed.)
- Tamarack Mortality in Minnesota Due to Larch Sawfly Outbreak, by L. C. Beckwith and A. T. Drooz. Jour. Forestry 54: 268-269. 1956.